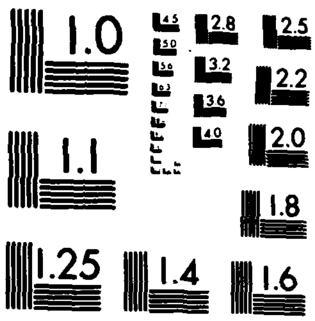
AD-A138 569 PERFORMANCE EVALUATION OF A MAGNAVOX GPS (GLOBAL POSITIONING SYSTEM) Z-SET(U) DEFENCE RESEARCH ESTABLISHMENT OTTAWA (ONTARIO) M F VINNINS APR 83 1/1

UNCLASSIFIED DREO-TN-83-3 F/G 17/7 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNCLASSIFIED

RESEARCH AND DEVELOPMENT BRANCH

DEPARTMENT OF NATIONAL DEFENCE

CANADA

DEFENCE RESEARCH ESTABLISHMENT OTTAWA

TECHNICAL NOTE NO. 83-3

PERFORMANCE EVALUATION OF A MAGNAVOX GPS Z-SET

by

M. Vinnins

Electromagnetics Section

Electronics Division

PROJECT NO.
32G10

APRIL 1983
OTTAWA

UNCLASSIFIED

ABSTRACT

A Magnavox Global Positioning System (GPS) Z-Set Receiver was obtained on loan from the United States NAVSTAR/GPS Joint Program Office for evaluation. Tests were carried out in an electronically-equipped trailer, on-board a naval research vessel and in a Twin Otter flying laboratory. Data was manually recorded during static positioning tests and waypoint navigation tests. Results indicated a static positioning accuracy consistantly better than 100 feet in both latitude and longitude under 4-satellite availability.

RESUME

Le Joint Program Office du systéme de localisation par satellite NAVSTAR nous a prêté un récepteur Z-set du système de localisation par satellite Magnavox pour en faire l'évaluation. Nous avons effectué des tests dans une remorque munie d'équipements électroniques et installée à bord de recherche, et dans un laboratoire aménagé à bord d'un Twin Otter. On a enregistré à la main les données lors de tests de positionnement au point fixe et de tests de navigation par point de cheminement. Dans tous les cas, la position au point fixe pouvait toujours être déterminée avec une marge d'erreur de moins de 100 pieds en latitude et en longitude, à partir de quatre satellites.

TABLE OF CONTENTS

1.0 BACKGROUND

The Navigation Sub-program at the Defence Research Establishment Ottawa is involved in many aspects of navigation technology. Over the past five years, direct support has been provided to the Canadian Marconi Company (CMC) who are under contract to develop a Class 'D' (2-channel, high accuracy, medium dynamics) GPS receiver scheduled for delivery in early 1984. In addition a newly-developed Marine Integrated Navigation System (MINS) designed and built at DREO began sea trials in mid-1982.

In order to satisfy the requirement for a reference system against which to evaluate the MINS and as preparation for delivery of the Canadian - built GPS receiver, a request was submitted to the GPS Project Office for the loan of a GPS receiver. A Magnavox GPS Z-Set was loaned to DREO for the months of October, November and part of December 1982. This report summarizes some of the tests performed on this receiver and the results obtained.

1.1 TEST PHILOSOPHY

Detailed performance evaluation of the Magnavox GPS Z-Set has been performed by the GPS Joint Program Office and it was not our intent to repeat any of that work. Instead, our evaluation was aimed at acquiring some 'hands-on' experience with the GPS System in as many environments as possible within the time span of the receiver loan. The principal purposes of the tests were to establish GPS as a credible primary location sensor at sea for testing and evaluating MINS-derived location accuracies and to demonstrate GPS to the Canadian Forces in various environments.

In preparation for the delivery of the CMC GPS receiver, test plans are in the process of being written for tests within land vehicles, ships and various aircraft. The Magnavox GPS Z-Set was employed (in a limited way) in each of these environments during our tests.

Since no interfacing capabilities were provided with the receiver, data collection was limited to that available through switch selection on the Control Display Unit (CDU). The results of these tests are presented here.

1.2 THE MAGNOVOX Z-SET

The Magnavox GPS Z-Set is a single-channel, low dynamics, C/A code-only receiver. Performance specifications for this receiver are taken from the Magnavox Z-Set User Manual (April 1982) and are shown in Table 1-1.

Photographs of the receiver as installed onboard a Twin Otter test aircraft are shown in Figures 1-1, 1-2 and 1-3. Figure 1-1 shows the Control Display Unit (CDU), on the right Figure 1-2 the Receiver Processor Unit (RPU)

PARAMETERS	CHARACTERISTICS
OPERATIONAL	
RF Signal input level	-163 to -150 dBW, L_1 1575.42 MHz
Maximum dynamics	
Velocity	0-400 meters per second
Acceleration	0-5 meters per second^2 (between 5 m/s^2 and 10 m/s^2 set will enter HOBYT)
Antenna coverage	Reception of satellite signals more than 5 degrees above horizon
Equipment stabilization period	Less than 15 minutes from turn-on to the start of data acquisition between 0 to + 49°C
Static propagation delay error (GDOP less than 5)	Error in displayed navigation solution less than 180 meters
Fix accuracy	500 meters
Pseudorange measurement accuracy	15 meters (C/A-signal)
Jamming-to-signal power ratio	Up to 25 dB
Data recovery	Undetected bit error rate less than 0.00001 with jamming-to-signal ratio of 25 dB
Time-to-first-fix	
Normal (wide) acquisition mode	Less than 300 seconds
Narrow acquisition mode*	Less than 215 seconds
Digital output signal	2.4 kilobits per second
PHYSICAL	
Volume	0.016 cubic meter
Weight	15 Kilograms
Power	53 Watts

* Position uncertainty <13 Km
Initial velocity uncertainty <17 m/s

TABLE 1-1

Performance Details

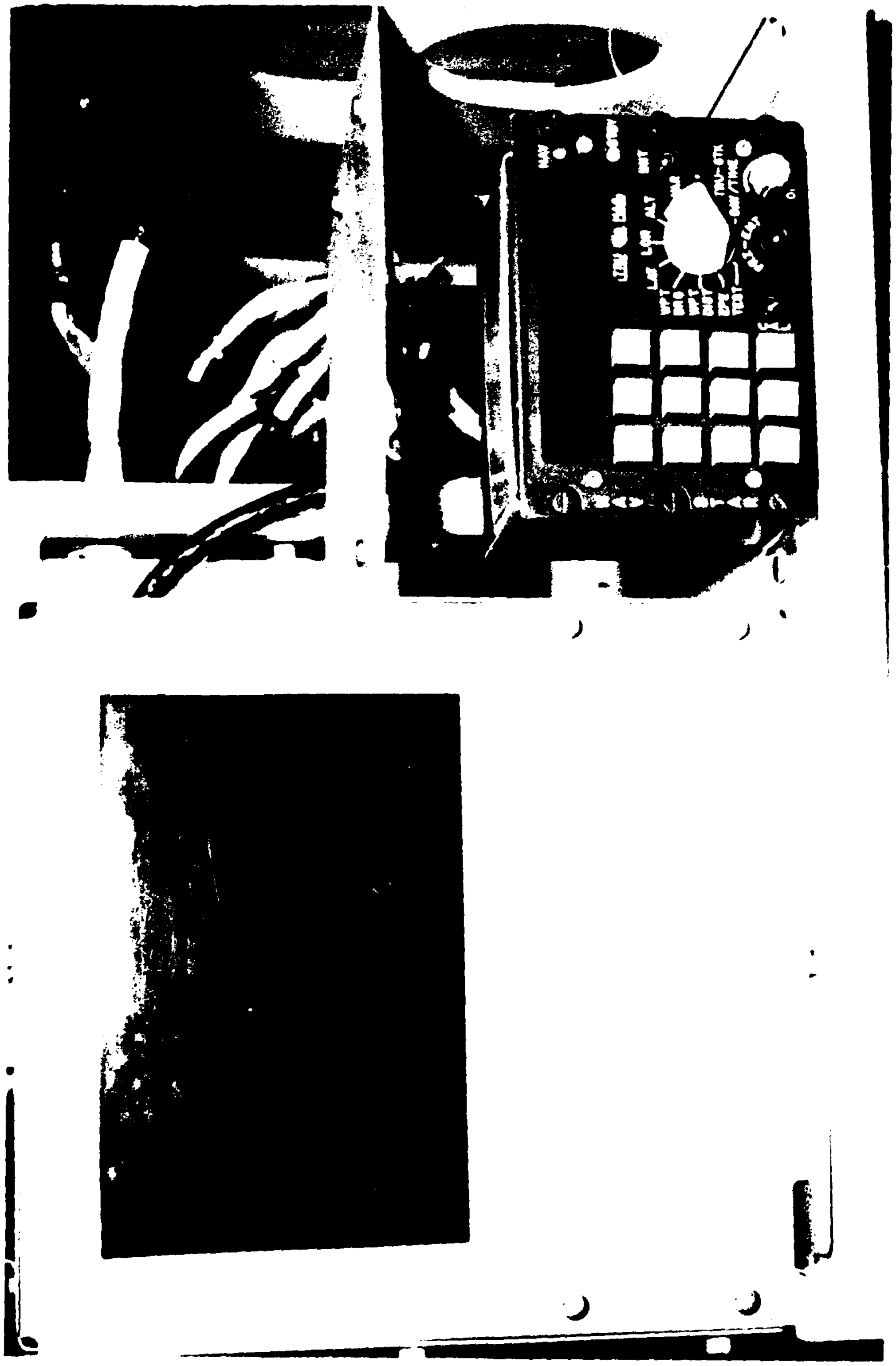


Fig. 1-1 Magnavox GPS Z-Set CDU

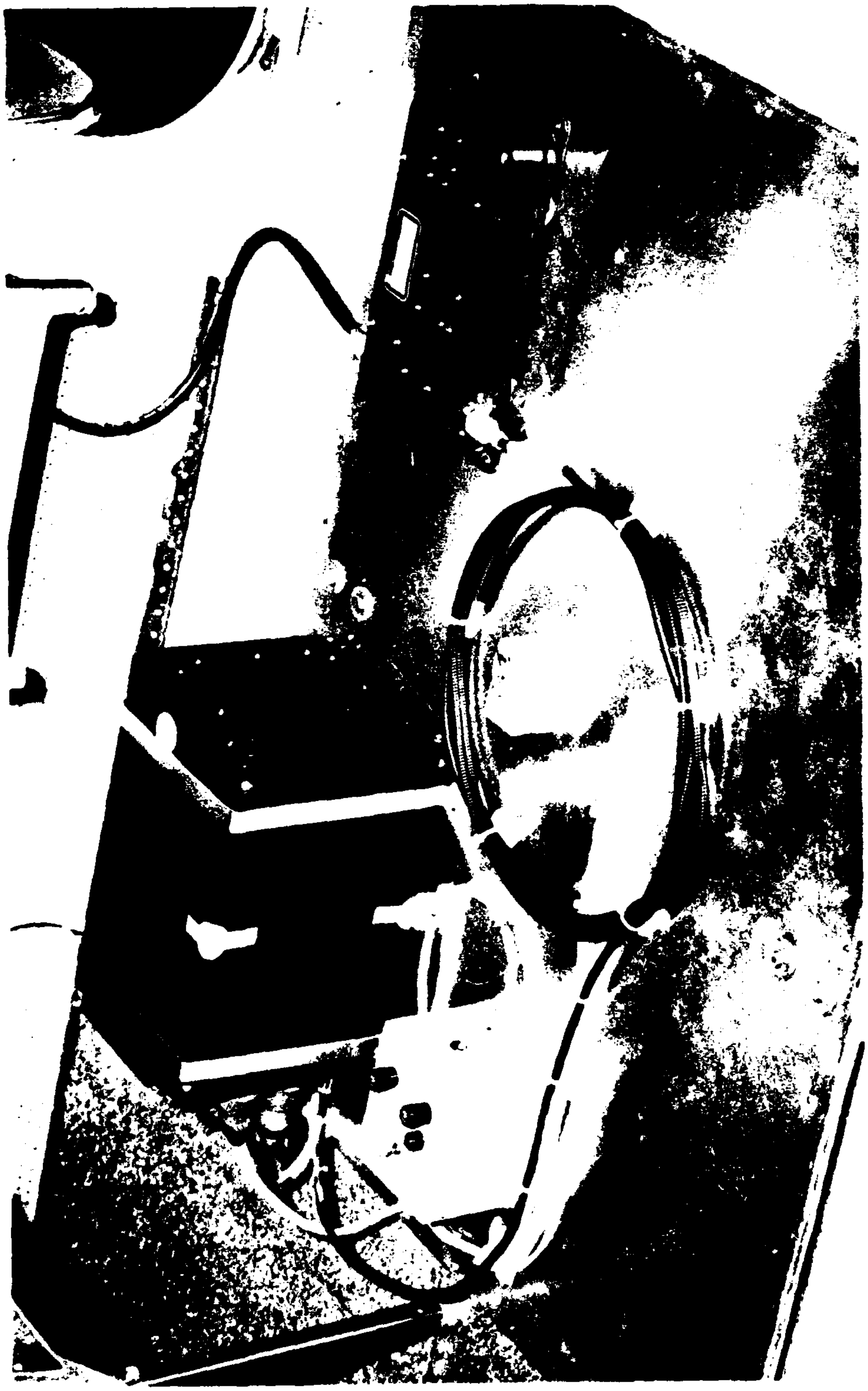


Fig. 1-[illegible] [illegible] Installation

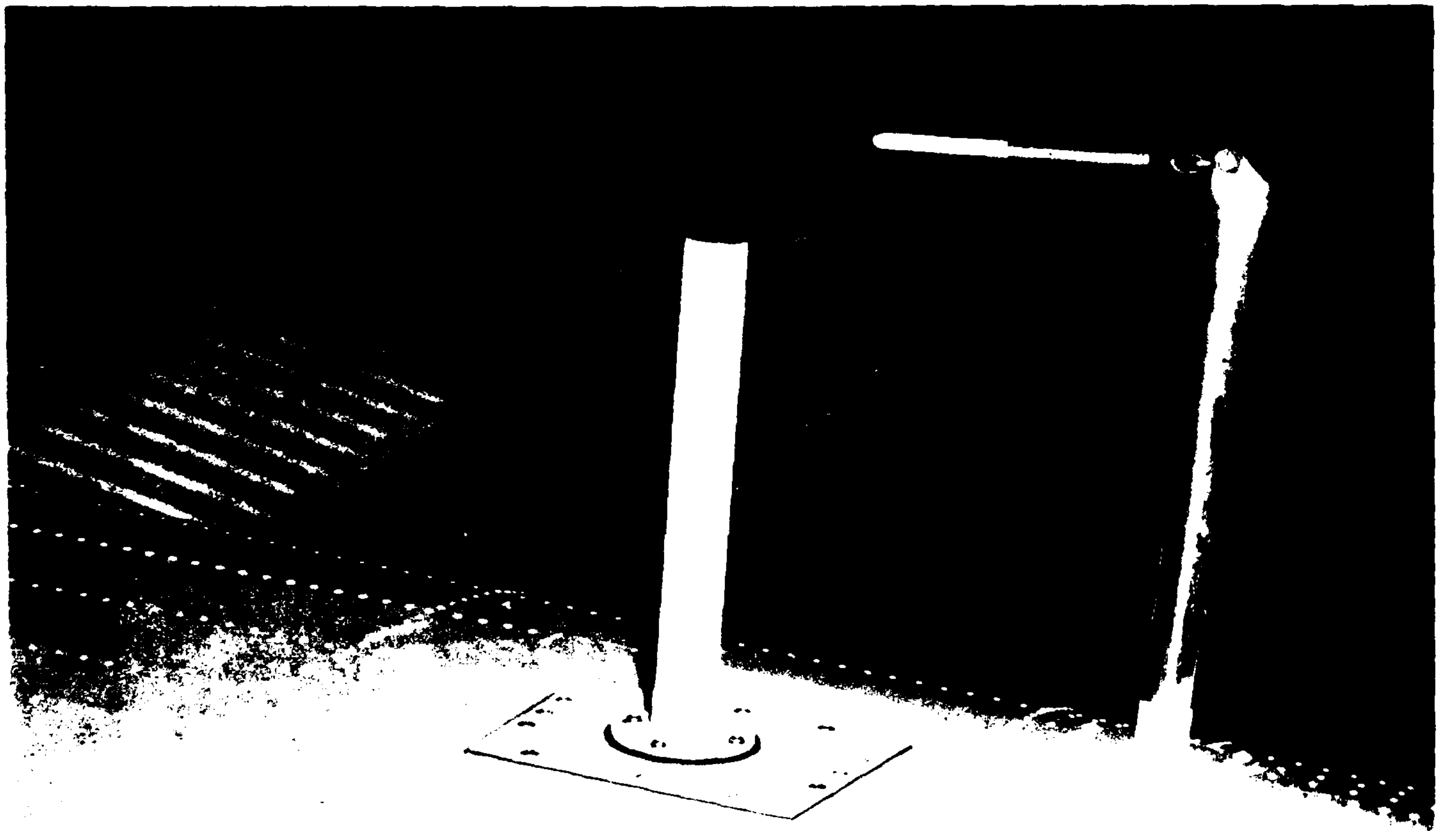


Fig. 1-2 HF Clam Antenna Installed on [illegible]

and RF preamp and Figure 1-3 the Chu antenna that was employed during all of the tests.

Satellite coverage during the entire test period was quite limited. Four-satellite coverage was available for only 2 hours a day but fortunately occurred during the late morning and early afternoon facilitating demonstrations to future operational users as an additional benefit to the tests. A computer plot of Geometric Dilution of Precision (GDOP) vs time of day is shown in Figure 1-4 and elevation angle vs time of day in Figure 1-5. Note that the best coverage in the Ottawa area occurred between 1745 and 1915 hrs (GMT) or 1245 and 1415 hrs local time with a GDOP between 2 and 7. (GDOP is an indicator of satellite geometry with respect to the user).

2.0 TEST PROCEDURES

Tests were carried out on three different platforms; a fully instrumented van, a naval research ship and a Twin Otter 'flying-laboratory' aircraft.

2.1 VAN TESTS

Tests on an instrumented van were carried out between 5 November and 1 December 1982. Prior to installation, the receiver was checked for proper operation. A problem was discovered with the Magnavox antenna so a Chu antenna (as shown in Figure 1-3) was substituted and receiver operation verified.

For the purposes of determining receiver static positioning accuracy, verifying proper operation and performing speed calibration and low-dynamics way point navigation, a survey crew was hired to locate and mark a series of existing first-order survey points which could be accessed by truck in the local Ottawa area. A list of the waypoints and their positions is given in Table 2-1.

Some of the selected survey points were in fact, some distance from the road so stakes were driven into the ground at the shoulder of the road and then the distance and bearing to the survey marker were taken if possible. The latitude and longitude of each stake was then calculated with reference to its nearby survey marker. By this method, the exact position of the stakes is known to within several feet and the van can be brought to a stop within twenty feet (or less) of most stakes.

Table 2-1 also contains the corrected latitude and longitude for each stake used in the tests. Unfortunately, some stake positions could not be accurately determined because the corresponding survey markers were several hundred feet away from the road in heavy underbrush; these were left uncorrected in the data.

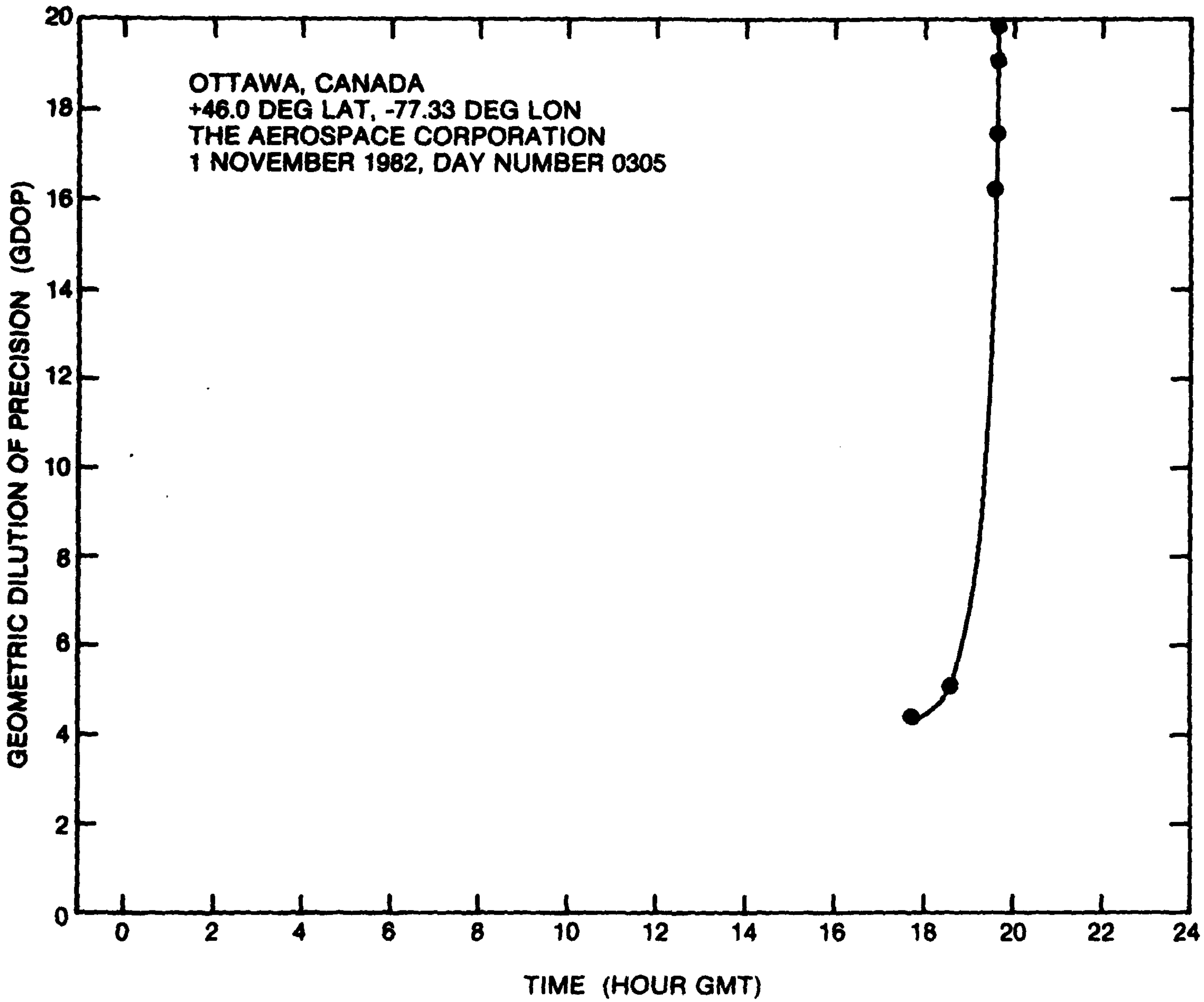


Fig. 1-4 4-Satellite GDOP

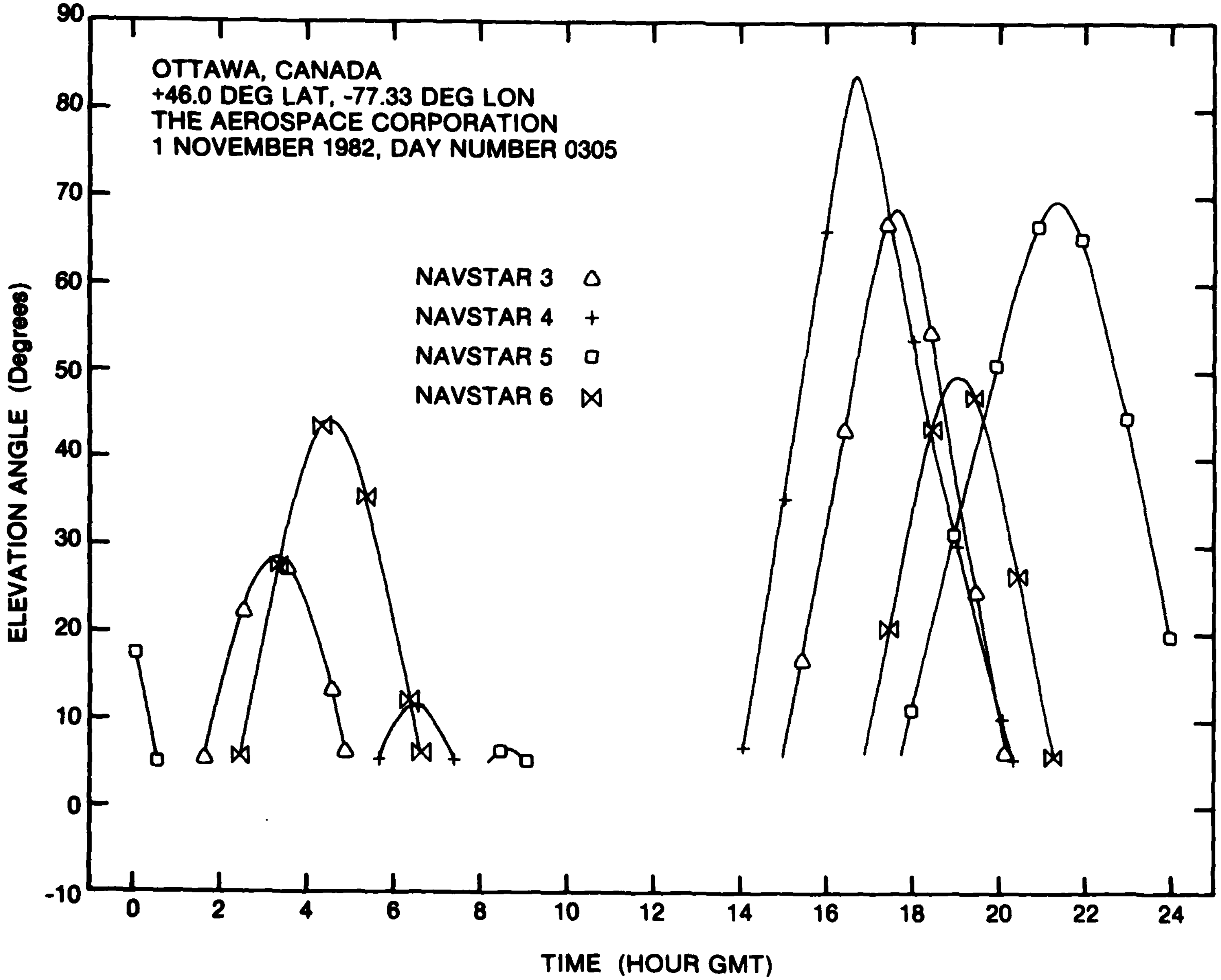


Fig. 1-1 Elevation Angles to NAVSTAR Satellites

TEST POINT NO.	NAME	LATITUDE	LONGITUDE	(CORRECTED) STAKE POSITIONS LATITUDE	LONGITUDE
0	DREO TOWER	45° 20' 55"	75° 52' 53"	45° 20' 55"	75° 52' 53"
				(No correction possible)	
	WOODLAWN	45° 27' 43"	76° 04' 35"	45° 27' 42.23"	76° 04' 34.67"
2	DIRLETON	45° 29' 01"	76° 09' 37"	45° 29' 01"	76° 09' 39"
				(No correction possibble)	
5	ARNPRIOR	45° 25' 23"	76° 19' 39"	45° 25' 23.12"	76° 19' 38.68"
9	PANMURE	45° 29' 18"	76° 11' 04"	45° 20' 18"	76° 11' 04"
8	MARATHON	45° 21' 06"	76° 06' 50"	45° 21' 5.4"	76° 06' 49.73"
0	DREO TOWER	45° 20' 55"	75° 52' 53"	45° 20' 55"	75° 52' 53"

NOTE: 1. This Route is a Subset of a Surveyed Route Containing a Total of 12 'Waypoints'.

TABLE 2-1

Route No. 1

The test procedure consisted of initializing the receiver at the start point, the DREO Tower, where all four satellites were acquired before each test was begun. The time, actual position, receiver latitude, longitude and altitude, Estimated Position Error (EPE) and number of satellites being tracked were recorded. An example of a test data sheet is shown in Table 2-2.

The position of each subsequent survey point along the route was then loaded into the receiver as a waypoint and the distance and bearing from the present (start) position to the first waypoint was also recorded. The van was then driven and parked at each waypoint where all receiver data were taken and the distance and bearing to the next waypoint were recorded.

This entire procedure was carried out six times between 5 Nov. and 1 Dec 1982. In actual fact, as many as 12 waypoints were used in some tests but limited satellite coverage often resulted in 2 and 3-satellite fixes with poor GDOP since the tests often over-ran the coverage times. Most data presented here are from a so-called 'short' route during which 4-satellite coverage was always available.

In addition a fifth-wheel system was used as a velocity reference during several tests. GPS velocity was recorded and later plotted for comparison.

2.2 SHIP TESTS

During the week of 15-20 Nov. 1982, the DREO - developed Marine Integrated Navigation System (MINS) was taken to Victoria, B.C. for demonstrations and sea trials onboard the research vessel CFAV Endeavour.

The GPS Z-Set was installed on the ship as a reference system against which MINS could be compared.

Unfortunately, due to the early hours of satellite visibility and the fact that the ship had not left dockside during the visibility period, due to bad weather no useful navigation data were acquired during this period. Plans are in progress to secure the loan of another GPS receiver during 1983 such that another series of sea trials can be carried out using GPS as a reference system.

2.3 AIRCRAFT TESTS

After completion of the van tests, the GPS Z-Set was installed in a Twin Otter research aircraft owned by the National Aeronautical Establishment. The photos previously shown as Figures 1-1, 1-2 and 1-3 are actually those of the installation on the Twin Otter.

DATE 5 Nov. 82 TEMP. 10°C HUMIDITY 70% CLOUD COVER Cloudy

TIME (GMT)	WAYPOINT NO & LOCATION			RECEIVER			DIST/BRG TO WAY POINT	
	NO.	LAT.	LONG	LAT	LONG	EPE	DIST	BRG
ARR. DEP. 1800	0 DREO TOWER	45° 20' 55"	75° 52' 53"	45° 21' 01"	75° 52' 54"	.01	10.6NM .0NM	309.2°T
ARR. 1820 DEP. 1823	1 WOODLAWN	45° 27' 43"	76° 04' 35"	45° 27' 43"	76° 04' 35"	.01	3.8NM .1NM	290.1°T 204.3°T
ARR. 1836 DEP. 1839	2 DIRELTON	45° 29' 01"	76° 09' 37"	45° 28' 59"	76° 09' 33"	.01	9.0NM .1NM	243.2°T 306.7°T
ARR. 1858 DEP. 1900	3 ARNPRIOR	45° 25' 23"	76° 19' 39"	45° 25' 18"	76° 19' 29"	.02	7.8NM .1NM	130.1°T 332.4°T
ARR. 1912 DEP. 1912	4 PANMURE	45° 28' 18"	76° 11' 04"	45° 20' 13"	76° 11' 00"	.02	3.3NM .0NM	61.3°T -
ARR. 1921 DEP. 1923	5 MARATHON	45° 21' 06"	76° 06' 50"	45° 21' 06"	76° 06' 50"	.02	9.8NM .1NM	91.0°T 176.9°T
ARR. 1948 DEP.	6 DREO	45° 20' 55"	75° 52' 53"	45° 21' 00"	75° 52' 53"	.03	--- ---	--- ---
ARR. DEP.	7 BLDG. T5			45° 20' 51"	75° 53' 07"	.05	--- ---	--- ---

TABLE 2-2

GPS TEST DATA SHEET

It was decided that in order to get useful results, it would be best to attempt a series of single point positioning tests over a precisely known and closely accessible survey point. Such a point was that of the intersection of two runways at the Ottawa International Airport. The aircraft could carry out touch-and-go passes from either runway, and it was estimated that an 'on-top' could be called with an error of less than twenty feet. In actual fact, the aircraft did not touch down on the runway, but rather 'glided' approximately six feet above the ground.

Two flights employing this 'touch-and-go' method were flown totalling over 25 data points. Data were recorded by voice onto tape and later transcribed to data sheets. Data recorded included EPE, latitude, longitude, altitude, speed, True Ground Track and time.

A series of waypoint navigation tests was also carried out. Three easily accessible landmarks in the Ottawa area (DREO Tower, Ottawa VOR and the airport runway intersection) were chosen as waypoints and the triangular route was flown several times. This test was used mainly to acquire a feel for receiver performance as a baseline for later comparison with other receivers and systems to be tested.

The tests were completed and the receiver was returned to the JPO on 10 Dec. 1982.

3.0 TEST RESULTS

Since all data were recorded manually, the data were limited to that which were available via the CDU only and by the one-second rate at which the displays are updated.

3.1 VAN TEST RESULTS

Table 3-1 shows a comparison between the survey marker positions and the GPS Z-Set positions for each of the six test runs as well as the averaged GPS Z-Set position. The most notable characteristic of the data is its repeatability; although each run was done on a different day and at a different time, rarely is the difference in position greater than one second of arc (approximately 100 feet) and is, in fact, usually identical.

It is interesting to note that for three of the waypoints (DREO Tower, Dirleton and Panmure) the marker at the roadside is actually several hundred feet from the survey point. Using the waypoint navigation function, it was possible to get a bearing and distance to the waypoint while parked at the roadside marker. The most notable example of this occurs using the data gathered at the DREO Tower. It can be seen from the averaged GPS positions

WAYPOINT NAME	Stake Position		Receiver Position Run #1 (5 Nov)		Run #2 (8 Nov)		Run #3 (9 Nov)	
	Lat.	Long.	Lat.	Long.	Lat.	Long.	Lat.	Long.
DREO TOWER	$45^{\circ}20'55''$	$75^{\circ}52'53''$	$45^{\circ}21'01''$	$75^{\circ}52'54''$	$45^{\circ}21'01''$	$75^{\circ}52'54''$	$45^{\circ}21'01''$	$75^{\circ}52'55''$
WOODLAWN	$45^{\circ}27'42.23''$	$76^{\circ}04'34.67''$	$45^{\circ}27'43''$	$76^{\circ}04'35''$	$45^{\circ}27'44''$	$76^{\circ}04'35''$	$45^{\circ}27'43''$	$76^{\circ}04'34''$
DIRELTON	$45^{\circ}29'01''$	$76^{\circ}09'37''$	$45^{\circ}28'59''$	$76^{\circ}09'33''$	$45^{\circ}28'58''$	$76^{\circ}09'33''$	$45^{\circ}28'59''$	$76^{\circ}09'33''$
ARNPRIOR	$45^{\circ}25'23.12''$	$76^{\circ}19'38.68''$	Missed	Marker	$45^{\circ}25'24''$	$76^{\circ}19'38''$	$45^{\circ}25'24''$	$76^{\circ}19'38''$
PANMURE	$45^{\circ}20'18''$	$76^{\circ}11'04''$	$45^{\circ}20'13''$	$76^{\circ}11'00''$	$45^{\circ}20'14''$	$76^{\circ}11'06''$	$45^{\circ}20'14''$	$76^{\circ}11'06''$
MARATHON	$45^{\circ}21'5.4''$	$76^{\circ}06'49.73''$	$45^{\circ}21'06''$	$76^{\circ}06'50''$	$45^{\circ}21'05''$	$76^{\circ}06'50''$	-	-
DREO TOWER	$45^{\circ}21'55''$	$75^{\circ}52'53''$	$45^{\circ}21'00''$	$75^{\circ}52'53''$	$45^{\circ}20'58''$	$75^{\circ}52'52''$	$45^{\circ}20'58''$	$75^{\circ}52'52''$

TABLE 3-1

Van Test Results

WAYPOINT NAME	Receiver Position Run #4 (25 Nov) Lat.	Long.	Run #5 (30 Nov) Lat.	Long.	Run #6 (1 Dec) Lat.	Long.	Average Position Lat.	Long.
DREO TOWER	-	-	45 21 00	75 52 54	45 21 01	75 52 54	45 21 0.8	75 52 54.2
WOODLAWN	45°27'44"	76°04'34"	45°27'43"	76°04'33"	45°27'43"	76°04'43"	45°27'43.2"	76°04'34.2"
DIRELTON	45°28'59"	76°09'33"	56°28'59"	76°09'33"	45°28'59"	76°09'33"	45°28'58.8"	76°09'33"
ARNPRIOR	45°25'24"	76°19'38"	45°25'23"	76°19'38"	45°25'23"	76°19'38"	45°25'23.6"	76°19'38"
PANMURE	45°20'14"	76°11'07"	45°20'14"	76°11'05"	45°20'14"	76°11'06"	45°20'13.8"	76°11'05"
MARATHON	-	-	45°21'06"	76°06'51"	45°21'05"	76°06'51"	45°21'5.5"	76°06'50.5"
DREO TOWER	45°21'04"	75°52'56"	45°21'02"	75°52'55"	45°20'51"	75°52'48"	45°20'59"	75°52'54"
	(3	Satellites)			(2	Satellites)		

TABLE 3-1

Van Test Results (Cont'd)

that, in fact, GPS and the survey coordinates disagree by approximately 580 feet in latitude and 85 feet in longitude. While parked at the tower, the receiver consistantly gave a bearing to the waypoint of 170° True. If one calculates the bearing from the latitude and longitude difference, the result is 168° True! Evidently, the survey location seems incorrect. In fact, after discussions with the survey crew, it was learned that the coordinates given to us had been taken from an old map and that the tower had since been moved. A comparison of the old map and the tower position led us to conclude that the tower had, indeed, been moved approximately 600 feet on a bearing of 350° T.

Table 3-2 shows the deviation between survey marker position and GPS position. Note that for the three corrected markers (Woodlawn, Arnprior and Marathon) the average GPS position is within 100 feet of the stated survey position. For the three uncorrected markers, the bearing and distance to the waypoint as given by the receiver agree closely with the calculations (as done for the DREO Tower). The consistancy and repeatability demonstrated during these tests was most impressive.

In addition to static positioning and waypoint navigation, we were most interested in the velocity (Gnd-Speed) indication provided by the receiver. It is, in fact, this feature which has most impressed people to whom the system has been demonstrated. A 'fifth wheel' system connected to the test van allowed accurate velocity comparisons to be made during the tests. A velocity profile taken during one of the tests is shown in Figure 3-1. It can be seen that the velocity derived from the GPS receiver agrees very closely with that of the fifth wheel although a slight offset of approximately 1 to 1½ miles per hour is noticeable on several sections of the plot. This could be due to a mis-calibration of the fifth wheel which was not checked before beginning the tests due to lack of time but has since been corrected.

3.2 SHIP TEST RESULTS

No useful data were acquired during the MINS sea trials since only a one-day trial was carried out and, unfortunately, satellite coverage was not available during the necessary time. An attempt will be made to repeat these tests in the spring and summer of 1983 during continuing MINS sea trials.

3.3 AIRCRAFT TEST RESULTS

Table 3-3 shows the data taken during a 1½ hour, point-positioning touch-and-go flight test using a runway intersection as a traget point. Again, it can be seen that the data are very consistant; in fact, the limitation here is the 1-second updata rate of the CDU displays which limits the resolution of the position data. When averaged, the GPS position is within 50 feet in latitude and 100 feet in longitude of the survey position. This data is presented in another fashion in Figure 3-2. Note the quantization error due to the arc second resolution of the CDU display. To eliminate possible

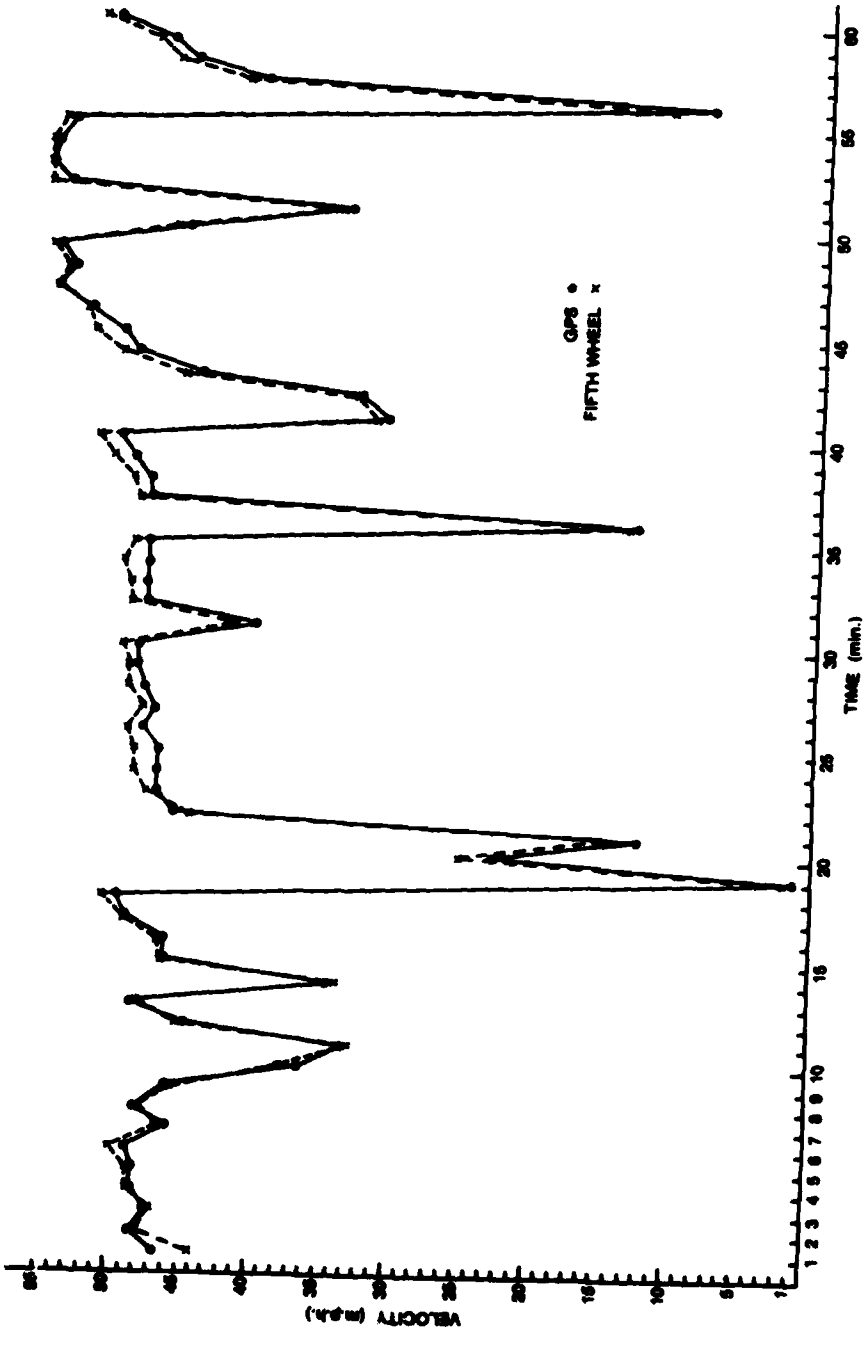


Fig. 3-1 GPS Velocity Profile

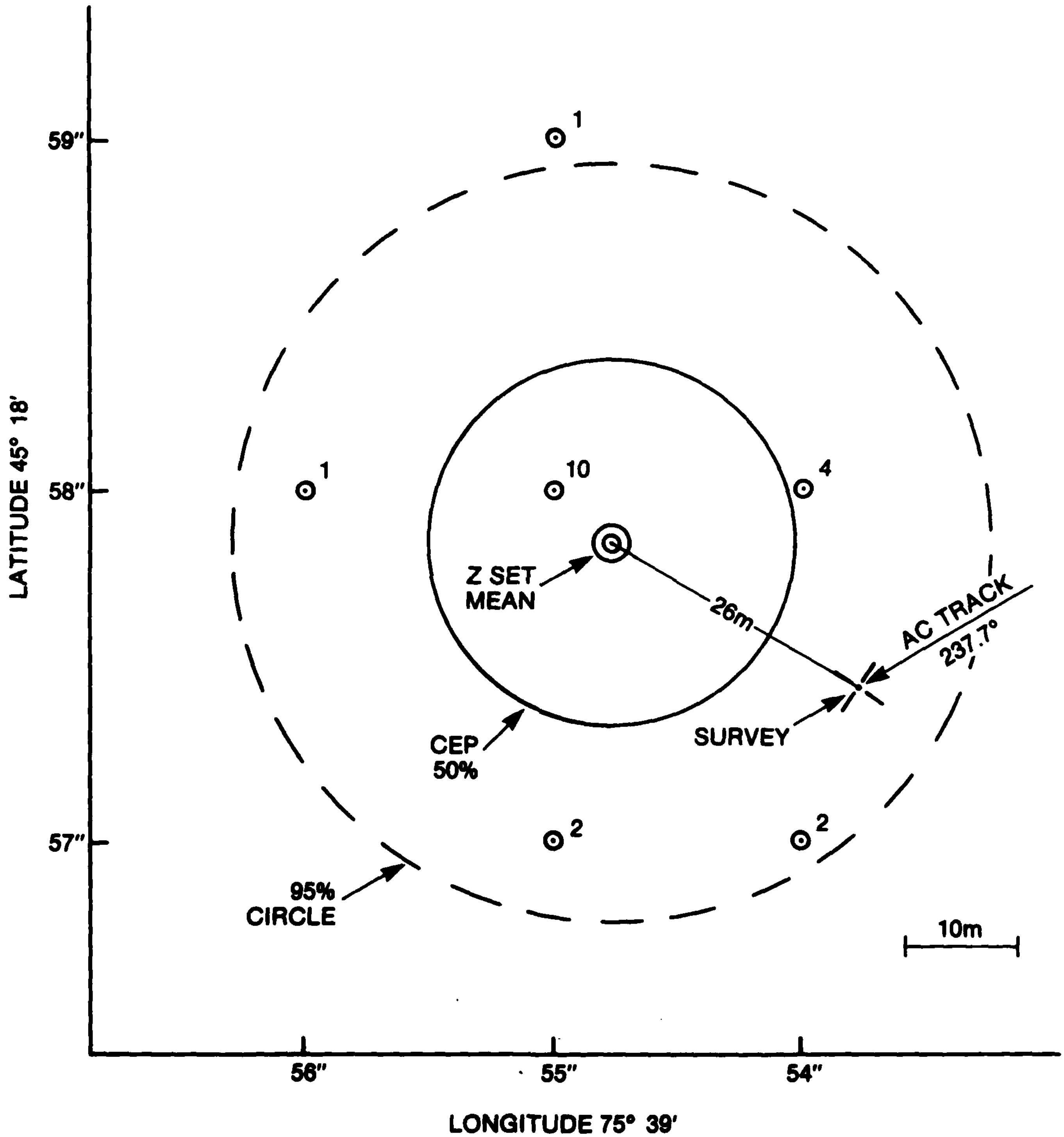


Fig. 3-2 Z-Set on Twin Otter (82/12/7)

	POSITION DEVIATION Δ Lat.	ΔLong.	DISTANCE GPS TO SURVEY MARKER	CALCULATED BEARING	GPS RECEIVER BEARING TO WAYPOINT
DREO TOWER	-5.8"	-1.2	580' South 85' East	168^{0}T	170.3^{0}T
WOODLAWN	-1.07"	+.47"	107' South 35' West	-	-
DIRLETON	+2.17"	+4.00"	217' North 280' West	295.5^{0}T	306.7^{0}T
ARNPRIOR	-.48"	.68"	48' South 48' West	-	-
PANMURE	+4.17"	-1.0"	417' North 71' East	13.6^{0}T	17.4^{0}T
MARATHON	-.1"	-.77"	10' South 54' East	-	-
DREO TOWER	04.0"	-1.0"	400' South 71' East	166^{0}T	170^{0}T

Δ Lat = Survey Lat. - Avg. Lat. (GPS)

Δ Long = Survey Long-Avg. Long (GPS)

1 sec ≈ 30 m ≈ 100' of Latitude
1 sec ≈ 71' of longitude

TABLE 3-2

GPS Deviation From Survey Marker

PASS #	LATITUDE	LONGITUDE	GND SPD	Gnd Tk	EPE
1	45° 18' 57"	75° 39' 54"	73 knots	237.8	.01NM
2	45° 18' 58"	75° 39' 54"	74	237.4	.02
3	45° 18' 57"	75° 39' 55"	67	238.2	.04
4	45° 18' 58"	75° 39' 55"	74	238.1	.02
5	45° 18' 57"	75° 39' 54"	76	237.8	.02
6	45° 18' 58"	75° 39' 55"	75	238.0	.02
7	45° 18' 57"	75° 39' 55"	74	237.7	.02
8	45° 18' 58"	75° 39' 55"	77	237.5	.02
9	45° 18' 58"	75° 39' 55"	80	237.1	.02
10	45° 18' 58"	75° 39' 54"	81	237.6	.02
11	45° 18' 58"	75° 39' 55"	80	237.3	.02
12	45° 18' 58"	75° 39' 55"	78	237.4	.02
13	45° 18' 58"	75° 39' 54"	84	237.7	.02
14	45° 18' 58"	75° 39' 54"	80	236.6	.04
15	45° 18' 58"	75° 39' 55"	81	238.3	.03
16	45° 18' 58"	75° 39' 55"	79	237.6	.02
17	45° 18' 58"	75° 39' 55"	72	237.5	.03
18	45° 18' 59"	75° 39' 55"	73	238.7	.03
19	45° 18' 58"	75° 39' 54"	87	237.8	.04
20	45° 18' 58"	75° 39' 54"	78	237.6	.04
21	45° 18' 58"	75° 39' 54"	81	237.0	.04

GPS Avg. Lat = 45° 18' 57.86"

GPS Avg. Long = 75° 39' 54.71"

Runway Intersection:

Lat = 45° 18' 57.44"

Long = 75° 39' 53.75"

Δ Lat = .42" Δ Long = .96"

TABLE 3-3

Twin Otter/GPS Data 7 Dec. 82

measurement biases, the same survey point was approached from a different direction along the second runway. The results indicated no significant bias:

GTK = 237^{o} (Runway 07)	Avg. Lat. = 45^{o} 18' 57.85"
	Avg. Long = 75^{o} 39' 56"
GTK = 306^{o} (Runway 24)	Avg. Lat = 45^{o} 18' 58"
	Avg. Long = 75^{o} 39' 56"

It is interesting to note at this point that during the circuits being run between the Airport runway intersection, DREO Tower and Ottawa VOR, the results were, again, much the same except for the DREO Tower. Using the (incorrect) coordinates for the tower, each time the waypoint was passed, displays frozen and the data recorded, the results indicated that the actual waypoint location was 5 arcseconds in latitude and slightly less than 2 arc-seconds in longitude away on a bearing of approximately 166^{o} True. As discussed in section 3.1, the reason for this was later discovered yet the consistancy and accuracy of the data in its agreement with the earlier van tests was most impressive.

4.0 CONCLUSIONS

Evidently, these tests were not by any means extensive nor did they prove anything new or remarkable about the Magnavox GPS Z-Set or the GPS System in general. On the other hand, the remarkable repeatability and consistant system performance did a great deal to improve our confidence and expectations of GPS performance. This will be invaluable in the upcoming extensive tests of the Canadian-built receivers. The opportunity to demonstrate the system to potential military users and employ it in various operational environments helps lend credibility to the high expectations one has of GPS when reading the literature.

ACKNOWLEDGEMENTS

We would like to extend our sincere appreciation to the GPS Joint Program Office and to the NATO GPS Steering Committee for making the loan of this receiver possible.

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA – R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1 ORIGINATING ACTIVITY DEFENCE RESEARCH ESTABLISHMENT OTTAWA NATIONAL DEFENCE HEADQUARTERS OTTAWA CANADA K1A 0Z4	2a DOCUMENT SECURITY CLASSIFICATION 2b GROUP

3 DOCUMENT TITLE

PERFORMANCE EVALUATION OF A MAGNAVOX GPS Z-SET

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
TECH NOTE

5 AUTHOR(S) (Last name, first name, middle initial)

VINNINS, MICHAEL F.

6. DOCUMENT DATE 23 Feb. 83	7a. TOTAL NO OF PAGES	7b NO OF REFS

8a. PROJECT OR GRANT NO 32G01	9a ORIGINATOR'S DOCUMENT NUMBER(S)
8b CONTRACT NO	9b. OTHER DOCUMENT NO.(S) (Any other numbers that may be assigned this document)

10. DISTRIBUTION STATEMENT

UNLIMITED DISTRIBUTION

11 SUPPLEMENTARY NOTES	12. SPONSORING ACTIVITY

13 ABSTRACT

A Magnavox Global Positioning System (GPS) Z-Set Receiver was obtained on loan from the United States NAVSTAR/GPS Joint Program Office for evaluation. Tests were carried out in an electronically-equipped trailer, on board a naval research vessel and in a Twin Otter flying laboratory. Data was manually recorded during static positioning tests and waypoint navigation tests. Results indicated a static positioning accuracy consistantly better than 100 feet in both latitude and longitude under 4-satellite availability.

DSIS
77-065

UNCLASSIFIED
Security Classification

KEY WORDS

NAVSTAR/GPS
MAGNAVOX Z-SET
SATELLITE NAVIGATION
POSITION FIXING

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the organization issuing the document.

2a. DOCUMENT SECURITY CLASSIFICATION: Enter the overall security classification of the document including special warning terms whenever applicable.

2b. GROUP: Enter security reclassification group number. The three groups are defined in Appendix 'M' of the DRB Security Regulations.

3. DOCUMENT TITLE: Enter the complete document title in all capital letters. Titles in all cases should be unclassified. If a sufficiently descriptive title cannot be selected without classification, show title classification with the usual one-capital-letter abbreviation in parentheses immediately following the title.

4. DESCRIPTIVE NOTES: Enter the category of document, e.g. technical report, technical note or technical letter. If appropriate, enter the type of document, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the document. Enter last name, first name, middle initial. If military, show rank. The name of the principal author is an absolute minimum requirement.

6. DOCUMENT DATE: Enter the date (month, year) of Establishment approval for publication of the document.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the document.

8a. PROJECT OR GRANT NUMBER: If appropriate, enter the applicable research and development project or grant number under which the document was written.

8b. CONTRACT NUMBER: If appropriate, enter the applicable number under which the document was written.

9a. ORIGINATOR'S DOCUMENT NUMBER(S): Enter the official document number by which the document will be identified and controlled by the originating activity. This number must be unique to this document.

9b. OTHER DOCUMENT NUMBER(S): If the document has been assigned any other document numbers (either by the originator or by the sponsor), also enter this number(s).

10. DISTRIBUTION STATEMENT: Enter any limitations on further dissemination of the document, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this document from their defence documentation center."

(2) "Announcement and dissemination of this document is not authorized without prior approval from originating activity."

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document, even though it may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall end with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (TS), (S), (C), (R), or (U).

The length of the abstract should be limited to 20 single-spaced standard typewritten lines, 7½ inches long.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a document and could be helpful in cataloging the document. Key words should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context.